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COMPLIMENTARY

**PUBLIC WORKS DEPARTMENT,
PUNJAB.**

IRRIGATION BRANCH.

**SUTLEJ DAM PROJECT
1919.**

VOLUME

V.

WESTERN JUMNA CANAL.

REPORT AND ESTIMATES.



SUTLEJ DAM PROJECT.

VOLUME V.

WESTERN JUMNA CANAL

REPORT AND ESTIMATES.

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SUTLEJ DAM PROJECT.

WESTERN JUMNA CANAL.

REPORT.

1. *History of Canal up to the present.*—The history of the development of the Western Jumna Canal and proposals for extending it have been dealt with in the "Report on the physical description of the tract and History of Irrigation therein" (see Volume I), so all that is necessary here is to deal with details of the present project submitted.

2. *Aim of the extensions.*—It should be borne in mind that the aim of the Project is to spread the benefits of irrigation into the whole tract lying between the Sutlej and the Jumna Rivers up to the limit of command, irrespective of territorial boundaries, physical conditions only being given their due consideration.

If the object was to get the best returns on the capital to be sunk, the method adopted would probably be very different to that proposed. The most paying scheme would be to utilise the extra water available by increasing the intensity of irrigation in existing channels up to a maximum possible, only utilising the balance available, for extensions.

3. *Short description of the Canal.*—The Western Jumna Canal takes its supply from the Jumna River at Tajewala and is entitled to two-thirds of the supply in the river, the Eastern Jumna Canal in the United Provinces being entitled to the other third.

From Tajewala the Main Line carrying a supply of 6,430 cusecs is navigable and runs down an old bed of the River Jumna for the greater part of its 51-miles length. A small area of irrigation is done direct from the Main Line as the villages had ancient rights in the use of water for irrigation purposes, prior to the re-construction of the present canal.

At Indri the canal bifurcates and the Sirsa Branch, which takes off on the right bank, carrying 1,790 cusecs, is 115 miles long and irrigates a strip of country right down to Sirsa itself. This Branch which was the last to be constructed on the canal was built in 1895. It was originally intended to be a kharif channel only, but it was found that rabi crops sown on it, with a first watering only, failed to mature so the supply on the older branches was cut down in the rabi and a portion given to the Sirsa Branch, much to the benefit of the whole system, as the tract around the Delhi Branch was notoriously water-logged owing to excessive irrigation.

The Main Branch runs for 31 miles from Indri to Munak, where it bifurcates into the Delhi and Hansi Branches, the Delhi Branch running 76 miles to Delhi.

The Hansi Branch, originally, as the Ferozeshah Canal ran right down into Bikaner territory, from Dhatrat onwards its alignment lies in the bed of the Chautang Nala which ceased to flow centuries ago. This Branch was navigable up to Hansi, but lately the Branch has been deemed to end at Rajthal, mile 48, beyond which point it is known as the Hissar Major Distributary.

4. *Sarda-Ganges Project.*—Mr. Ward in 1910 submitted, in alternative, the "Project for the Extension of irrigation in the Punjab under the Sarda-Ganges-Jumna Feeder scheme, Western Jumna Canal extensions," hereinafter given the short title of Sarda-Ganges Project.

Mr. Gordon, the Chief Engineer, in his note, dated 10th April 1911, made certain modifications, and the Project was then printed up and submitted to the Government of India with Secretary Irrigation's No. 702 W.I., dated 12th February 1911.

The Punjab Government have recently given up all claim to help from the Sarda-Ganges-Jumna Scheme.

H. W. M. ILLS—23-5-10.

Chief Engineer.

The extensions of irrigation, from all the Branches except the Sirsa Branch, under the Sutlej Dam Project, are all based on the Sarda-Ganges Project referred to.

In writing this report it is presumed that a copy of the printed Sarda-Ganges Project is available for reference.

5. The Larger Project.—The first alternative was called the Larger Project; in this case an average supply of 1,400 cusecs was to be brought across the Jumna River in a syphon and passed into the Main Branch between Karnal and Munak.

6. The Lesser Project.—The other alternative was called the Lesser Project; in this case an average additional supply of 816 cusecs was to be passed into the Main Line of the Western Jumna Canal at Tajewala from the River Jumna. The water was to be made available in the Jumna by part of the Eastern Jumna Canal system being supplied by a feeder from the Ganges which set free an average supply of 816 cusecs at its head at Tajewala.

7. Capital cost involved and returns expected.—The main details of the areas to be irrigated, etc., by the two Projects are here given:—

	<i>Larger Project.</i>	<i>Lesser Project.</i>
Total extra area of irrigation, acres ..	350,000	204,000
Extra average supply at Canal Head, cusecs	1,400	816
Duty annual, acres per cusec ...	250	250
Capacity Factor ...	0.5	0.5
<i>At Distributary Head—</i>		
Duty annual	300	300
Capacity Factor	0.5	0.5
Full Supply Factor	150	150
Total capital cost, Rs. ...	2,06,94,055	1,04,64,341
Capital cost per acre of irrigation, Rs. ...	59.1	51.3
Net revenue per acre, Rs. ...	3.21	3.28
Returns on Capital	5.4%	6.4%

8. The extensions proposed common to the alternative Projects.—The two Projects were exactly similar except that owing to more water being available in the one case than in the other extensions in additional tracts were possible.

In both cases the first arrangement made was to increase the intensity of irrigation in all existing distributaries which were designed for less than 33½% to that figure.

The extensions proposed from the Delhi Branch were the same in both cases. The Pai and Bhalaut Distributaries were both to be extended up to the physical limit of irrigation. The head reach of the Bhalaut Distributary was to be amalgamated with the Rohitak Distributary for 8 miles in which length they run alongside with only a bank between them.

The extensions from the Hansi Branch were really not to be done directly from that Branch, but from the Butana Branch which takes off from the Hansi Branch.

The Tosham extension was to take up the hitherto unirrigated tract between the irrigation limits of the Hansi and Butana Branches.

The greater portion of the water required for increasing the permissible intensity of irrigation was utilised in the Bhiwani and Kanhaur Distributaries from the Butana Branch.

9. Sirsa Branch extensions.—The Barwala tract lying between the limits of irrigation of the Sirsa and Hansi Branches was provided for under both projects, and provision was made for increases in various existing distributaries. The Larger Project provided for irrigating the large tract between the limit of irrigation of the Sirsa Branch and the Ghaggar Nala, nearly as far east as Kaithal.

10. The reason of abandonment of the Sarda-Ganges Project.—This Project depended for its supply of water on the construction of

the canal from the Sarda to the Ganges River in the United Provinces. As this latter Project has not reached maturity nothing could be done with the Punjab developments depending on it.

11. Sarda-Ganges Project Records.—The whole of the Project Records prepared by Mr. Ward in such complete detail have been used in this Project, and it has been found unnecessary to make any fresh plans or estimates in the estimating in connection with the Western Jumna Canal for the Sutlej Dam Project.

12. Portion of the canal transferred to the Sirhind System.—The Sirsa Feeder, from the Upper Sirhind Canal, will meet the Sirsa Branch below the Fall at mile 33 and relieve the Western Jumna Canal of the responsibility of the capacity of the Sirsa Branch at that point (1,242 cusecs on longitudinal section).

The tail of the Habri Distributary, taking off higher up the Sirsa Branch, will also be cut off and attached to the Upper Sirhind Canal system giving further relief of 82 cusecs capacity. The Sirsa Branch below the Fall at mile 17, to the junction of the Sirsa Feeder, will be abandoned and the section of the Branch in the reach above that Fall contracted in accordance with the less supply that will be required, giving a saving in absorption, all told, of 92 cusecs.

The Barwala extension from the Upper Sirhind Canal will take up the irrigation from the Hissar Major Distributary around Hissar, requiring 40 cusecs capacity, thus enabling a long length of this Distributary, in the bed of the old Chautang Nala, which is very inefficient, to be abandoned.

The total credits to the canal available for extensions will, therefore, be— $1,242 + 82 + 92 + 40 = 1,456$ cusecs.

13. Maps and Appendices.—On the general Project map a light green wash is given over the area within the irrigation limits of those distributaries in which the percentage is increased.

Accompanying this report are Appendices A to H which give in tabular form all the changes proposed in the various distributaries on the Branches. Appendix I^a gives a general abstract showing in tabular form all the changes by branches for the whole canal.

The estimates of the cost of the various changes and the general abstract estimate of cost for the whole canal are attached to this report.

14. Increases in intensity on existing channels.—Since Mr. Ward prepared the Sarda-Ganges Project the capacities and figures for areas on nearly all the distributaries have been changed, as will be seen from the printed pamphlet, Capacity Statements, Western Jumna Canal, 1916. In all cases the intensity of irrigation proposed has already been brought up to a uniform level of $33\frac{1}{3}$ per cent., wherever it was previously less.

Under the Sutlej Dam Project the intensity of irrigation is fixed at a minimum of 40 per cent., so that further increases in capacity are given to certain distributaries to bring the intensity up to this level. No increase has, however, been made on the $33\frac{1}{3}$ per cent., for the Nardak Distributary from the Main Branch as it is in a tract of high rainfall as mentioned later.

On the Delhi Branch the distributaries have an intensity of irrigation of 45 per cent., or over, with the exception of the Bhalaut Distributary. It is deemed desirable to bring the intensity on that distributary up to 45 per cent., to make it equal to that in the extensions to be done from it in the Pai Rohana tract. The total extra capacity given to existing distributaries will be 315 cusecs. See Appendix I^a, column 11.

15. Extensions from existing Distributaries of Delhi Branch.—The only extension from this Branch is known as the Beri Bhalaut extension which is arranged by remodelling the Pai and Bhalaut Distributaries and prolonging them into the tract. The increase in capacity required will be 269 cusecs. See Appendix F., column 1.

The amalgamation of Bhalaut and Rohtak Distributaries for the 8 miles where they run alongside, is a desirable feature in the method of carrying the increased discharge required in the Bhalaut, for raising the intensity of irrigation and the extensions proposed.

These two channels run side by side causing great percolation losses in a tract of remarkably high spring level. In view of the favourable conditions that exist for the execution of the work, it would be an extremely satisfactory solution to effect the increase in capacity required, by working one channel full time and line the other with concrete, thereby obtaining the increased capacity required, at the same time saving the percolation losses which are so detrimental.

This is a proposal which could be carried into effect apart from and before the construction of this Project as a charge to the open canal, so that no provision is made in the Sutlej Dam Project on this account.

16. Extension of irrigation from the Butana Branch.—The Tosham extension, the largest of those left to be supplied from the Western Jumna, is irrigated by a Distributary carrying 586 cusecs which takes off from this Branch.

In the Tosham extension is included a gross commanded area of 74,500 acres in Jind State; a further area of 20,000 acres in Jind State near Dadri is commanded by an extension of the Kanhaur Distributary. This irrigation will be done by British channels, and no attempt will be made to give the State separate channels, for irrigation under separate management, in these tracts.

The total increase in capacity required in the Branch for all the above extensions is 634 cusecs. *See Appendix F., column 11*

Much alteration will be needed in the Branch to obtain the increased capacity, but, were the channel to be lined with concrete, the increased capacity would be obtained with very little change in its section.

The cost of this proposal to line the Branch has not, however, been provided for in the Project, as it would have added much to the detailed estimating required and also to the capital cost of a Project, which already involves the heaviest expenditure of any Project hitherto prepared and for which it is very difficult to show satisfactory financial returns, owing to the small amount of credit that can be taken from the benefits it causes.

It is probable that this case of lining and that of the combined Bhalaut and Rohtak Distributaries, will be carried out on the recommendations of the newly constituted Provincial Drainage and Seepage Board when they turn their attention to this tract, as the Superintending Engineer of the Western Jumna Canal admits the desirability of the action proposed.

17. Extension from the Hansi Branch.—A reconnaissance survey was made of the tract beyond the tail of the Petwar Distributary south-west of Hissar around Balsamand, as in the evidence given before the Irrigation Commission of 1901-03, it had been stated that the extension of irrigation in this tract was very desirable, but no contour maps existed.

The extra capacity required in the Petwar Distributary is 153 cusecs, of this 40 cusecs is obtained in the Branch owing to that amount of capacity being cut off the tail of the Hissar Major Distributary and fed through the Barwala extension of the Sirsa Branch. This leaves an increase of 113 cusecs capacity required in the Hansi Branch up to the off-take of the Butana Branch. *See Appendix F., column 11.*

Above the off-take of the Butana Branch up to the head, the increase in capacity required will be 863 cusecs which will mean heavy alterations to the Branch which might be lessened, were the changes to be combined with the introduction of a concrete lining.

18. Extensions from the Sirsa Branch.—The Chantang Canal practically entirely depends on the surplus water available in the Sirsa Branch for its supply, and the Superintending Engineer, Western Jumna Canal, is very desirous of giving it an assured supply through the Sirsa Branch under the Sutlej Dam Project, so that provision has been made accordingly. He objects to giving the channel a kharif supply only as there are no kharif distributaries existing on the Canal at present. The question then arises, why not start the good work of converting perennial into kharif distributaries on this canal now, as was done many years ago.

on the Upper Bari Doab Canal, and Sirhind Canal, since the annual rainfall is greater and spring level over large areas very high. The reply is "vested interests"; probably by the time this project comes to take effect, many of the distributaries in the notoriously water-logged tracts will have been converted into kharif channels, which will have made it possible for some of the extensions proposed under this Project to have been carried out in the meantime.

19. Estimates.—No detailed estimates beyond those attached have been made for the work in connection with this Project. The abstracts of the Sarda-Ganges Project are accepted so far as I—Works is concerned, and all the items varied in accordance with a proportion fixed on in the estimates for the various portions.

The detailed abstract, pages 8 and 9, shows the cost according to the Sarda-Ganges Project of each extension and the conversion factor fixed to give the probable cost of the extensions, with the capacities now provided. Establishment and Tools and Plant charges are fixed on the percentage; accepted for the rest of the Sutlej Dam Project under the new rules; as a matter of fact the extensions proposed will not require any great increase in establishment over that required for ordinary maintenance on the canal.

20. Final result of all the changes.—Appendix F shows that the total irrigation on the Western Jumna Canal, as left after the Project is completed, will be 49,494, say, 50,000 acres more than is done on the canal as it exists at present; this is due to the saving of all the absorption in the 98-miles length of the Sirsa Branch and the different Full Supply Factors that are fixed in the Capacity Statement of the Western Jumna Canal, 1916.

There is no doubt that the modifications in the canal will, owing to a higher intensity of irrigation being allowed for, cause an increase in efficiency of irrigation as demonstrated by Mr. Gibb.

The working expenses will be reduced as one less Division will be required on the canal and the length of main channel to be maintained will be 98 miles less.

No attempt is made to work out a financial statement for the Western Jumna alone, the whole of the canals are lumped together for this purpose and dealt with in the general report.

All the areas irrigated by the extensions from the Western Jumna Canal are in the tracts most subject to famine in the Punjab. The question of famine is, however, dealt with separately in the General Report on the whole Project.

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Sirhind Canal.

SUTLEJ DAM PROJECT.

WESTERN JUMNA CANAL.

ESTIMATES.

ESTIMATE

ABSTRACT ESTIMATE SHOWING COST OF BRANCHES AND DISTRIBUTARIES AS

HEAD OF CLASSIFICATION.	MAIN CANAL AND BRANCHES.					
	Enlarging Main Branch.		Enlarging Hansi Branch and Butana Branch.		Enlarging Delhi Branch.	
	Amount according to Sarda-Ganges Project.	Amount according to Sutlej Dam Project.	Amount according to Sarda-Ganges Project.	Amount according to Sutlej Dam Project.	Amount according to Sarda-Ganges Project.	Amount according to Sutlej Dam Project.
1	2	3	4	5	6	7
A.—DIRECT CHARGES.		$1\frac{1}{8}$ times.		$1\frac{1}{4}$ times.		$1\frac{1}{8}$ times.
I—(2) Main Canal and Branches—						
A.—Preliminary	22,114	27,642	1,176	1,764
B.—Land	24,478	30,598	1,008	1,512
D.—Regulators	55,618	69,516
E.—Falls and weirs ...	378	504	41,459	51,824	268	395
F.—River and Hill Torrent works
F. 1.—Other cross drainage works ...	3,074	4,099	15,707	19,634	630	945
G.—Bridges ...	3,168	4,224	1,21,282	1,51,602	13,371	20,056
G. 1.—Canal crossings
I.—Navigation works	1,473	2,210
J.—Mills
K.—Buildings
L.—Earth-work ...	86,888	1,15,850	3,78,044	4,73,805	31,159	46,738
L. 1.—Lining
M.—Plantation
N.—Tanks and Reservoirs
O.—Miscellaneous	17,168	21,460	1,050	1,575
P.—Maintenance	10,069	12,586
Q.—Losses on stock
Total Main Canal and Branches ...	93,508	1,24,677	6,86,934	8,58,667	50,130	75,195
(3) Distributaries
(4) Drainage and Protection works
(5) Special Tools and Plant
Total of I—Works ...	93,508	1,24,677	6,86,934	8,58,667	50,130	75,195
II—Establishment 12% ...	21,507	14,961	1,57,991	1,03,040	11,530	9,023
III—Tools and Plant (ordinary) 1½% ...	2,805	1,870	20,603	12,880	1,503	1,128
IV—Suspense account	30,000	30,000	2,000	2,000
Total ...	1,17,820	1,41,508	8,95,536	10,04,587	65,163	87,346
V—Receipts on capital account	—5,000	—5,000	—1,000	—1,000
Total A.—Direct charges ...	1,17,820	1,41,508	8,90,536	9,99,587	64,163	86,346
B.—INDIRECT CHARGES						
VI—(23) Capitalization of Abatement of Land Revenue	5,475	5,475	225	225
(25) Leave and Pension allowance ...	3,011	2,094	22,119	14,426	1,614	1,263
Total B.—Indirect charges ...	3,011	2,094	27,594	19,901	1,839	1,488
Total Direct and Indirect charges ...	1,20,831	1,43,602	9,18,130	10,19,488	66,002	87,834
VII—Simple interest during construction						
						Dealt with for the

I.

ESTIMATES UNDER SARDA-GANGES PROJECT AND UNDER SUTLEJ DAM PROJECT.

DISTRIBUTARIES.										TOTAL AMOUNT OF WESTERN JUNNA CANAL EXTENSIONS.	
Tosham Distributary of Hansi Branch.		Enlarging Bhiwani Distributary of Hansi Branch.		Beri Bhalant Distributary of Delhi Branch.		Pat Rohana Distributary of Delhi Branch.		According to Sutlej Dam Project.		According to Sarda-Ganges Project.	According to Sutlej Dam Project.
Amount according to Sarda-Ganges Project.	Amount according to Sutlej Dam Project.	Amount according to Sarda-Ganges Project.	Amount according to Sutlej Dam Project.	Amount according to Sarda-Ganges Project.	Amount according to Sutlej Dam Project.	Amount according to Sarda-Ganges Project.	Amount according to Sutlej Dam Project.	Potwar Extension from Hansi Branch.	Chautang and other Distributaries on Road Reach of Sirsa Branch.		
8	9	10	11	12	13	14	15	16	17	18	19
	5% increase.		Same.		1 1/2 times.		1 1/2 times.				
...	23,290	29,406
...	25,486	32,110
...	55,613	69,516
...	42,100	52,723
...	19,411	24,678
...	1,37,821	1,73,882
...
...	1,473	2,210
...
1,35,188	1,41,948	18,984	21,357	9,492	10,678	1,63,664	1,73,983
...	4,07,691	6,36,393
...
8,663	9,096	1,680	1,680	10,843	10,776
...
...	15,218	23,035
...	10,069	12,586
...
1,43,851	1,51,044	1,680	1,680	18,984	21,357	9,492	10,678	1,04,579	12,43,298
6,95,246	7,30,008	3,43,150	3,48,150	3,93,436	4,42,616	1,37,238	1,54,393	2,77,000	80,000	15,74,070	20,32,167
...
...
8,89,097	8,81,052	3,49,830	3,49,830	4,12,420	4,63,973	1,46,730	1,65,071	2,77,000	80,000	25,78,049	32,75,465
1,78,162	1,05,726	77,130	41,980	80,457	55,677	33,743	19,808	33,240	9,600	5,66,528	3,93,055
23,238	13,216	10,060	5,247	11,277	6,960	4,162	2,476	4,155	1,200	73,893	49,132
2,40,000	30,000	20,000	20,000	20,000	20,000	10,000	10,000	1,12,000	1,12,000
10,70,197	10,29,994	4,57,020	4,17,057	5,30,154	5,48,610	1,91,880	1,97,355	3,14,395	90,800	33,31,070	38,29,652
5,000	5,000	11,000	11,000
10,65,197	10,24,994	4,57,020	4,17,057	5,30,154	5,48,610	1,91,880	1,97,355	3,14,395	90,800	33,20,070	38,18,652
26,375	26,375	3,225	3,025	11,339	11,339	5,520	5,520	52,159	52,159
24,946	14,802	10,898	5,877	12,003	7,795	4,725	2,773	4,654	1,344	78,313	55,028
61,318	41,177	11,123	9,102	23,842	19,134	10,245	8,293	4,659	1,344	1,31,472	1,07,187
1,16,615	1,06,171	4,71,143	4,28,159	5,53,490	5,65,744	2,05,125	2,05,648	3,19,049	92,144	34,51,542	39,25,839

Project as a whole in the General Report, Volume I.

SUTLEJ DAM PROJECT.

WESTERN JUMNA CANAL EXTENSIONS.

ESTIMATE 2.

Beri Bhalaut and Pai Rohana Extensions from Delhi Branch,
Western Jumna Canal.

IN the Sarda-Ganges Canal Project the increased mean discharge to be given to these two systems is given on page VI of that Project.

The mean discharge was based on a duty of 250 cusecs and the distributaries were designed with a Full Supply Factor of 150 cusecs, so that to get the increased capacity required it is necessary to multiply the mean discharge allocated by $\frac{250}{150}$ giving:—

Distributary.	Mean supply increased by cusecs.	Full supply increased by cusecs.
Beri Bhalaut ...	118	$\frac{118 \times 250}{150} = 197$
Pai Rohana ...	51	$\frac{51 \times 250}{150} = 85$
Total	169	282

The Sarda-Ganges Project aimed at bringing the irrigation on these two channels up to a minimum of 33½ per cent., and an increased capacity was given for that purpose as well as to give a 33½ per cent. intensity on the extensions.

Since the preparation of that Project the Capacity Statement of Western Jumna Canal, 1916, has been published, and this gives the capacities and percentages sanctioned as below.—

Distributary.	Gross area.	Culturable commanded area.	Percentage.	Annual irrigation proposed.	Full Supply Factor.	Full supply Discharge.
Bhalaut	143,081	33½	47,694	150	318
Pai	58,078	45	26,133	150	174
Total	192

Under the Sutlej Dam Project it is proposed to bring the percentage on the Bhalaut up to 45 per cent., the same as the intensity on the other distributaries of the Delhi Branch, and to give a 45 per cent. intensity, on a culturable commanded area of 90 per cent. of the gross area within irrigation limits, on the Beri Bhalaut and Pai Rohana Extensions. The gross area of these extensions taken from the original 1" to 1 mile tracing in the Sarda-Ganges Project Folio comes to 99,591 acres. The area to be done from the two distributaries respectively is a controversial question, and is referred to in a note dated 6th August 1917 by Mr. Laurie, Superintending Engineer, Western Jumna Canal. No attempt is therefore made to allocate the supply between the distributaries.

Taking both systems together the proposal now to be provided for is (See Appendix A):—

Distributary.	Gross area.	Culturable commanded area.	Percentage.	Annual irrigation proposed.	Full Supply Factor.	Full supply Discharge.
Bhalaut	143,081	45	64,886	150	429
Pai	58,073	45	26,133	150	174
Extensions ...	99,594	89,835	45	40,336	150	269
Total	872

or an increase of $872 - 492 = 380$ cusecs.

The cost of distributaries throughout the Sutlej Dam Project is based on the gross area within irrigation limits, and it has been found that the cost of the distributaries per acre on the Upper Chenab Canal and Lower Bari Doab Canals is independent of the intensity. On that basis of argument, there would be no call to increase the provision made under the Sarda-Ganges Project for these two distributary systems on account of the increased intensity proposed. As, however, the water has to be led through existing channels for some distance, increased provision is made as below.

The total capacity with the increase proposed under the Sarda-Ganges Project would have been $492 + 282 = 774$ cusecs whereas the capacity now proposed will be 872 cusecs, an increase of about $\frac{2}{3}$ or $12\frac{1}{2}$ per cent.

It is considered desirable to increase the provision under works for these two systems to $1\frac{1}{8}$ times the provision made in the Sarda-Ganges Project.

The provision made on page XI in Sarda-Ganges Project under I.—Works and that now proposed for the Sutlej Dam Project will thus be:—

		Sarda-Ganges Project.		Sutlej Dam Project.
Beri Bhalaut	...	4,12,420	$\times 1\frac{1}{8} =$	4,63,973
Pai Rohana	...	1,46,730	$\times 1\frac{1}{8} =$	1,65,071
		<hr/> 5,59,150 <hr/>		<hr/> 6,29,044 <hr/>

SUTLEJ DAM PROJECT.

WESTERN JUMNA CANAL EXTENSIONS.

ESTIMATE 3.

Alterations to Delhi Branch, Western Jumna Canal.

In the Sarda-Ganges Project the longitudinal section of the Delhi Branch showed an existing capacity at the head of 1,840 cusecs and the capacity proposed 1,753 cusecs, the anomaly is due to the fact that the head of the Gohana Feeder had been shifted above the Munak Head Regulator.

Below R. D. 25,000 feet, where the Gohana Feeder previously took off, the longitudinal section showed an existing capacity of 1,490 cusecs and the capacity proposed of 1,753 cusecs, an increase of 263 cusecs.

On page VI of the same Project the extra capacity required is—

Beri Bhalaut	$\frac{118 \times 250}{150}$	=	197
Pai Rohana	$\frac{51 \times 250}{150}$	=	85
Total					...	<u>282 cusecs.</u>

This difference of 21 cusecs is not clearly understood.

The increase of capacity of 263 cusecs shown on the longitudinal section was estimated to cost Rs. 50,130 for works only,—see page X of the Sarda-Ganges Project.

The increase in capacity now required at R. D. 25,000 is: for Bhalaut 111 cusecs and Pai 269 cusecs or 380 cusecs in all—(See Appendix A.)—or roughly 50 per cent. more than the 263 cusecs provided for under the Sarda-Ganges Project.

The estimated cost of works for increasing the capacity of the Delhi Branch in the Sutlej Dam Project is taken to be $1\frac{1}{2}$ times that provided in the Sarda-Ganges Project—Rs. 50,130 $\times 1\frac{1}{2}$ = Rs. 75,195.

The present authorised supply of the Delhi Branch according to the capacity statement of the Western Jumna Canal, 1916, Table 6, is 1,622 + 103 = 1,725 less 219 cusecs the capacity of the Gohana Feeder giving 1,506 cusecs at the Head of the Delhi Branch. This will now become 1,506 + 380 = 1,886 cusecs capacity.

SUTLEJ DAM PROJECT.

WESTERN JUMNA CANAL EXTENSIONS.

ESTIMATE 4.

Tosham Extension, Butana Branch, Western Jumna Canal.

In the Sarda-Ganges Project the irrigation to be done in this tract was fixed at $33\frac{1}{3}$ per cent. of the culturable commanded area, and on page VI of that Project a provision of 279 cusecs mean discharge equivalent to $\frac{279 \times 250}{150} = 465$ cusecs distributary head capacity was finally approved. The distributary was, however, designed with a head capacity of 518 cusecs.

The total area within irrigation limits as shown on the 1" to 1 mile tracing in the folio of the Sarda-Ganges Project gives an area of 244,372 acres, 90 per cent. of which is 219,934. The Sutlej Dam Project aims at giving 40 per cent. of 90 per cent. of the gross area as annual irrigation with a full supply factor of 150 cusecs, the latter being the same as that taken for the existing distributaries in the Butana Branch. Thus the channel will do 40 per cent. of $219,934 = 87,971$ acres of irrigation annually, and require a head capacity of $87,971 \div 150 = 586$ cusecs. (See Appendix C).

In all cases of new distributaries on the Sutlej Dam Project under Works 3—Distributaries the cost is estimated at Rs. 3 per acre gross within irrigation limits, this would give an amount of Rs. $2,44,372 \times 3 =$ Rs. 7,33,116.

On page XI of the Sarda-Ganges Project the amount estimated in detail is Rs. 6,95,246.

The gross area within irrigation limits remains the same, and on that basis of argument the cost of the distributaries would remain the same while the capacity is increased from 518 to 586 cusecs.

The cost by the acreage rate increases about 5 per cent. The original figures of cost in the Sarda Ganges Project with an addition of 5 per cent. are accepted for the whole of this extension.

The total provision under I—Works was Rs. 7,39,097 which is now increased by 5 per cent. to Rs. 8,81,052.

SUTLEJ DAM PROJECT.

WESTERN JUMNA CANAL EXTENSIONS.

ESTIMATE 5.

Bhiwani and Kanhaur Extensions, Butana Branch.

In the Sarda-Ganges Project on page VI the increased mean discharge required to raise the intensity of irrigation to $33\frac{1}{2}$ per cent. on these two distributaries is given as $113+20=133$ cusecs.

The mean discharge was based on a duty of 250 cusecs and the distributaries were designed with a Full Supply Factor of 150 cusecs to get the increased capacity required, it is necessary to multiply the mean discharge allocated by $\frac{250}{150}$ giving $\frac{133 \times 250}{150} = 221$ cusecs increased capacity.

Since the preparation of that Project the Capacity Statement of Western Jumna Canal, 1916, has been published and the following table gives the capacities and percentages sanctioned and also those now proposed under the project—(See Appendix C) :—

Distributaries.	Gross area.	Culturable commanded area.	Per-cent-age.	Annual irrigation proposed.	Full Supply Factor.	Discharge.
<i>Bhiwani—</i>						
Present	1,39,463	$33\frac{1}{2}$	46,488	150	310
Proposed	1,39,463	40	55,785	150	372
<i>Kanhaur—</i>						
Present	1,20,328	$33\frac{1}{2}$	40,109	150	268
Proposed	1,20,328	40	48,131	150	322
<i>Area in Jind (Dadri Tract).</i>						
Proposed ...	20,000	18,000	40	7,200	150	48
Total { Present	2,50,791	$33\frac{1}{2}$	86,507	150	578
Proposed	2,77,791	40	1,11,116	150	742
Increase	18,000	...	24,519	150	164

At the time the Sarda-Ganges Project was prepared, the authorised capacity of these two channels was 385 cusecs (see page 22 of Capacity Statement, Western Jumna Canals, 1916) which had increased to 578 by 1916.

The increase now proposed is 164 cusecs from a capacity of 578 cusecs to 742 cusecs whereas the Sarda-Ganges Project provided for an increase of 221 cusecs on a capacity of 385 cusecs to 606. This case is very difficult to estimate. Under the present conditions the absolute and percentage increase is less, but the area in Jind is new irrigation at the tail of the distributary which will entail more expense than simply increasing the intensity throughout the existing channel. The provision of Rs. 3,49,830 under Sarda-Ganges Project is taken as a fair estimate of the probable cost of the alterations proposed under the Sutlej Dam Project.

SUTLEJ DAM PROJECT.

WESTERN JUMNA CANAL EXTENSIONS.

ESTIMATE 6.

Petwar Extension from Hansi Branch.

Owing to the cutting off of the tail reach of the Hissar Distributary and supplying its capacity of 40 cusecs through the Barwala system, 40 cusecs capacity is set free at the head of the Hissar Distributary, which takes off the tail of the Hansi Branch at the same point as the Petwar Distributary does.

South-west of Hissar towards Balsamand a reconnaissance survey has been made which shows that there is a gross area of 64,000 acres which is irrigable and commanded.

In the Sarda-Ganges Project reference is made to this area, but there was not water left to irrigate it.

Taking 90 per cent. of gross area as culturable commanded and 40 per cent. irrigation the culturable commanded area would be 57,600 acres and the irrigation proposed 23,000 acres. With a Full Supply Factor of 150 as elsewhere on the Western Jumna Canal, the supply required would be 153 cusecs at head of the Petwar Distributary. (See Appendix B).

The extra supply in the Hansi Branch required would be $153 - 40 = 113$ cusecs.

	Rs.
The distributaries in the new area 64,000 at Rs. 3 per acre would cost	1,92,000
The capacity of the Petwar Distributary is at present 433 cusecs which would have to be increased to 586 cusecs, the capacity would have to be increased by 153 cusecs for the 26 miles length of the Petwar Distributary and 8 miles of the Satraund Branch Distributary, or 34 miles in all costing say Rs. 2,500 a mile	85,000
Total	2,77,000

The total cost under 3—Distributaries for this extension would therefore be Rs. 2,77,000, and provision is accordingly made in the Project.

SUTLEJ DAM PROJECT.

WESTERN JUMNA CANAL EXTENSIONS:

ESTIMATE 7.

Enlarging Hansi and Butana Branches.

In the Sarda-Ganges Project the Hansi Branch had to have its capacity increased to the head of the Butana Branch to supply the increased capacity required in the Butana Branch. On page VI of the Sarda-Ganges Project the increased mean discharge required was 412 cusecs equivalent to $\frac{412 \times 250}{150} = 686$ cusecs capacity. On page X of the same Project the total cost of I-Works is given as Rs. 6,86,934.

Under the Sutlej Dam Project the extra capacity required will be—

Hansi Branch—(See Appendix B)—

			Cusecs.	
Petwar Distributary	153	
Hissar Distributary	— 10	
			<u> </u>	113

Butana Branch—(See Appendix C)—

Tosham Distributary	586	
Bhiwani & Kanhaur	164	750
			<u> </u>	
	Total	...		<u>863 cusecs.</u>

The increase in capacity now required is 863 cusecs or 177 cusecs (roughly $\frac{1}{4}$) more than the 686 cusecs provided for under the Sarda-Ganges Project.

The estimated cost of works for the increased capacity required in the Hansi Branch in the Sutlej Dam Project is taken to be $1\frac{1}{4}$ times that provided in the Sarda-Ganges Project—

$$6,86,934 \times 1\frac{1}{4} = \text{Rs. } 8,58,667.$$

The present authorised supply of the Hansi Branch according to the Capacity Statement of the Western Jumna Canal, 1916, Table 6, is $1,317 + 873 = 2,190$. This will now become $2,190 + 863 = 3,053$.

SUTLEJ DAM PROJECT.

WESTERN JUMNA CANAL EXTENSIONS.

ESTIMATE 8.

Alterations to Main Branch, Western Jumna Canal.

In the Sarda-Ganges Project the longitudinal section of the Main Branch showed an existing capacity of 4,500 cusecs, which was to be raised to 5,418, an increase of 918 cusecs.

On page VI of the same Project the extra capacity required is—

Delhi Branch Extensions	$\frac{162 \times 250}{150}$... = 282 cusecs.
Hansi Branch Extensions	$\frac{412 \times 250}{150}$... = 686 „
Total	...	968 „

There is a difference of 50 cusecs which is not clearly understood, but probably being due to the fact that the capacity of the Branch was 50 cusecs more than necessary. The increase of capacity of 918 cusecs shown on the longitudinal section was estimated to cost Rs. 93,508 for works only, see page X of the Sarda-Ganges Project.

The increase in capacity now required is 1,250 cusecs (See Estimate No. 10) or 332 cusecs (roughly $\frac{1}{3}$) more than the 918 cusecs provided for under the Sarda-Ganges Project, requiring only about a further increase of 2 hissas in depth or 5 feet in bed width.

The estimated cost for works for the increased capacity required in the Main Branch in the Sutlej Dam Project is taken to be $1\frac{1}{3}$ times that provided in the Sarda-Ganges Project— $93,508 \times 1\frac{1}{3} = 124,677$.

The present authorised supply of the Main Branch according to the capacity statement of the Western Jumna Canal, 1916, Table 6, is 4,707; this will now become $4,707 + 1,243 = 5,950$ cusecs capacity.

SUTLEJ DAM PROJECT.

WESTERN JUMNA CANAL EXTENSIONS.

ESTIMATE 9.

Alterations to Chautang and other Distributaries left on the Head Reach of the Sirsa Branch, Western Jumna Canal.

(SEE APPENDIX D.) .

THE tail of the Habri Distributary has been cut off and a capacity of 82 cusecs transferred to the extension of the Sudkan for irrigating the tract round Uchana.

The authorised capacity of the Habri is 445 cusecs. After cutting off the 82 cusecs from the tail, the capacity at the head required to irrigate 40 per cent. in place of the $33\frac{1}{3}$ per cent. now allowed, becomes $(445-82) \times 40/33\frac{1}{3} = 435$ cusecs, a saving of 10 cusecs.

To increase the intensity from $33\frac{1}{3}$ to 40 per cent. on the remaining perennial channels taking out of the head reach of the Sirsa Branch, *viz.*, Karsa, Kaul, Mohana, Fatehpur and Chandana minors, an increase from 82 cusecs the present authorised supply to 98 cusecs or 16 cusecs capacity is required.

The Sirsa Branch will only remain to the fall R. D. 88,585 feet at the head of the Habri and a small feeder distributary will be taken off from above the fall to feed the minors, thereby saving the absorption in the Sirsa Branch, from R. D. 88,585 feet to R. D. 166,844 feet, which amounts to 47 cusecs.

The cost of this feeder distributary about 12 miles long at Rs. 2,500 a mile amounts to Rs. 30,000, and provision for this amount is made in the Project.

There will be no extra cost involved in the Habri Distributary as the capacity required will be 10 cusecs less than that now sanctioned.

The Chautang Distributary is fed from the Sirsa Branch, and in the Capacity Statement, Western Jumna Canal, 1916, Table 4, it is shown to have a capacity of 602 cusecs, but this is its capacity as an inundation canal. In table 3 the proposal to convert this channel into a regular kharif channel from the Sirsa Branch shows a capacity of 113 cusecs is required.

Mr. Laurie, Superintending Engineer, Western Jumna Canal Circle, in paragraph 3 of his note of 29th July 1917 on the extension of Western Jumna Canal under the Bhakra Dam Scheme desires to turn the Chautang Distributary into a perennial distributary with a head capacity of 68 cusecs. The cost of the alterations to the Chautang Distributary he gives in paragraph 4 (c) of the same note as being Rs. 50,000, and provision for this amount is made in the Project.

The total provision for alteration to distributaries on the head reach of the Sirsa Branch under I—Works, 3—Distributaries, therefore made is—

Rs.

Feeder Distributary for Minors 12 miles @ Rs. 2,500 a mile	=	30,000
Conversion of Chautang into a perennial Distributary of 68 cusecs capacity, figure given by Superintend- ing Engineer, Western Jumna Canal	=	50,000
Total		<u>80,000</u>

SUTLEJ DAM PROJECT.
WESTERN JUMNA CANAL EXTENSIONS.

ESTIMATE 10.

Alterations to the Head Reach of Sirsa Branch supplied from the Western Jumna Canal.

The Sirsa Feeder from the Upper Sirhind Canal cuts the Sirsa Branch below the Ohandana Fall at R. D. 166,844 feet, and the existing capacity of the Sirsa Branch at that point is taken over and supplied by the Upper Sirhind Canal. The details of the further alterations to the Sirsa Branch below this point do not concern the Western Jumna Canal portion of this project, and are dealt with in the report on the Upper Sirhind Canal.

The capacity of the Sirsa Branch at this point is shown as being 1,242 cusecs on the longitudinal section. From the draw off statement (Appendix H. attached) compiled for the Sirsa Branch as now existing, it will be seen that the capacity required below the fall including absorption in the Branch is 1,220 cusecs. Mr. Laurie, Superintending Engineer, Western Jumna Canal, in paragraph 2 of his note of 29th July 1917 takes the capacity at that point available as 1,230 cusecs, and presuming 20* cusecs

* Really only 10. However 1,250 is near enough for all practical purposes L. Section
 $1,242 + 10 = 1,252$.

(Ed.) E. R. For,
 S. E., S. C. C.

capacity the relief afforded to the Habri by cutting off its tail gives the capacity available at the head of the Sirsa Branch for extensions as 1,250 cusecs.

The reach of the Sirsa Branch from the fall at R. D. 88,585 feet below the head of the Habri Distributary to the fall at R. D. 166,844 feet will be abandoned and the minors in that reach will be fed by a small distributary (estimated for under Distributaries *ante*) running parallel to the abandoned Branch. The absorption saved in the reach will be 47 cusecs.

From the Head of the Branch to the Head of the Habri Distributary the discharge it now carries will be very much reduced. In paragraph 4 (b) of Mr. Laurie's note referred to above he estimates that when the channel section has been contracted the absorption will be 33 cusecs.

In the draw off statement mentioned above the present absorption in the reach is calculated to be 78 cusecs, the saving will therefore be $78 - 33 = 45$ cusecs.

On the Habri Distributary the capacity cut off at the tail and transferred to the Upper Sirhind Canal is 82 cusecs, but of this 72 cusecs is utilised in the upper reaches of the distributary itself to increase the percentage of irrigation from $33\frac{1}{2}$ to 40 per cent., leaving a net saving at Distributary Head of 10 cusecs.

To increase the percentage of irrigation from $33\frac{1}{2}$ to 40 per cent. on the six minors remaining to be supplied from this reach of the Branch, their total capacity will be increased from 82 cusecs to 98 cusecs, or an increase of 16 cusecs. The Chautang is given 68 cusecs as referred to in the details of alterations to distributaries in this reach.

The final result of these changes may be tabulated:—

	Present.	Proposed.	Difference.
Habri	415	435	- 10
Six Minors	82	98	+ 16
Chautang	...	68	+ 68
Absorption head to R. D. 88,585 feet	78	33	- 45
Absorption R. D. 88,585 feet to 166,844 feet	47	...	- 47
			+ 84
			- 102
Total	652	634	- 18

The total of 84 cusecs is the net increase. But really the gross increase of capacity utilised for irrigation must also include the 72 cusecs saved (see previous page) and utilised in the Habri itself out of the 82 cut off thus giving $84+72=156$ cusecs capacity. This with a Full Supply Factor of 150 acres will give an increase of $156 \times 150 = 23,400$ acres in the Distributaries on the Head Reach of the Sirsa Branch supplied from the Western Jumna Canal. (See Appendices D and F).

The total saving in capacity at the head of the Sirsa Branch available for utilisation by transfer to the Main Branch will be 18 cusecs, together with the capacity saved at the junction of the Sirsa Feeder 1,242 cusecs according to longitudinal section, or 1,220 cusecs according to the draw off statement compiled giving 1,260 and 1,238 cusecs, respectively, say 1,250 cusecs.

No provision is made for the cost of reducing the section of the Sirsa Branch above the fall R. D. 88,585 feet, the head of the Habri Distributary, as the Chief Engineer, Mr. Holms, considered the amount of Rs. 30,000 provided by Mr. Laurie, Superintending Engineer, Western Jamna Canal Circle, to be unnecessary as the channel would berm up of itself naturally.

SUTLEJ DAM PROJECT.
WESTERN JUMNA CANAL EXTENSIONS.

ESTIMATE 11.

II.—Establishment.

The provision for II—Establishment is made at the rate of 12 per cent. of total I—Works.

The detail is as below : -

Serial No. of channels.	Name of channels.	Total amount of I—Works.	Rate per cent	Total amount of II—Establishment.	REMARKS.
		Rs.		Rs.	
1	Enlarging Main Branch	1,24,677	12	14,961	
2	Enlarging Hansi Branch and Butana Branch.	8,58,667	12	1,03,040	
3	Enlarging Delhi Branch	75,195	12	9,023	
4	Tosham Distributary of Hansi Branch ...	8,81,051	12	1,05,726	
5	Enlarging Bhiwani Distributary of Hansi Branch.	3,49,880	12	41,980	
6	Beri Bhalaut Distributary of Delhi Branch	4,63,973	12	55,677	
7	Pai Rohana Distributary of Delhi Branch	1,65,071	12	19,808	
8	Petwar Extension from Hansi Branch ...	2,77,000	12	33,240	
9	Chautang and other distributaries in Head Reach of Sirsa Branch. ...	80,000	12	9,600	
	Total of II—Establishment ..	32,75,465	12	3,93,055	

SUTLEJ DAM PROJECT.**WESTERN JUMNA CANAL EXTENSIONS.****ESTIMATE 12.****III.—Tools and Plant (ordinary).**

The provision for III—Tools and Plant (ordinary) is made at the rate of $1\frac{1}{2}$ per cent. of total I—Works.

The detail is as below :—

Serial No. of channels.	Name of channels.	Total amount of I—Works.	Rate per cent.	Total amount of III—Tools and Plant (ordinary).	REMARKS.
		Rs.		Rs.	
1	Enlarging Main Branch	1,24,677	$1\frac{1}{2}$	1,870	
2	Enlarging Hansi Branch and Butana Branch.	8,58,667	$1\frac{1}{2}$	12,880	
3	Enlarging Delhi Branch	75,195	$1\frac{1}{2}$	1,128	
4	Tosham Distributary of Hansi Branch ...	8,81,051	$1\frac{1}{2}$	13,216	
5	Enlarging Bhiwani Distributary of Hansi Branch.	3,49,830	$1\frac{1}{2}$	5,247	
6	Beri Bhalaut Distributary of Delhi Branch	4,63,973	$1\frac{1}{2}$	6,960	
7	Pai Rohana Distributary of Delhi Branch	1,65,071	$1\frac{1}{2}$	2,476	
8	Petwar Extension from Hansi Branch ...	2,77,000	$1\frac{1}{2}$	4,155	
9	Chautang and other distributaries in Head Reach of Sirsa Branch.	80,000	$1\frac{1}{2}$	1,200	
	Total amount of III—Tools and Plant (ordinary).	32,75,465	$1\frac{1}{2}$	49,132	

SUTLEJ DAM PROJECT.
WESTERN JUMNA CANAL EXTENSIONS.

ESTIMATE 13.

IV.—Suspense Account.

The provision for IV—Suspense Account is kept the same as given in Sarda-Ganges Project.

The detail is as below :—

Serial No. of channels.	Name of channels.	Total amount of IV— Suspense Account.	REMARKS.
		Rs.	
1	Enlarging Main Branch	
2	Enlarging Hansi Branch and Butana Branch.	30,000	
3	Enlarging Delhi Branch ...	2,000	
4	Tosham Distributary of Hansi Branch.	30,000	
5	Enlarging Bhiwani Distributary of Hansi Branch.	20,000	
6	Beri Bhalaut Distributary of Delhi Branch.	20,000	
7	Pai Rohana Distributary of Delhi Branch.	10,000	
8	Petwar Extension from Hansi Branch.	...	
9	Chautang and other distributaries in head reach of Sirsa Branch.	...	
	Total	1,12,000	

SUTLEJ DAM PROJECT.**WESTERN JUMNA CANAL EXTENSIONS.****ESTIMATE 14.****V.—Receipts on Capital Account.**

The deduction of V—Receipts on Capital Account is kept the same as given in Sarda-Ganges Project.

The detail is as below :—

Serial No. of channels.	Name of channels.	Total amount of V—Receipts on Capital Account.	REMARKS.
		Rs.	
1	Enlarging Main Branch	
2	Enlarging Hansi Branch and Butana Branch.	5,000	
3	Enlarging Delhi Branch ...	1,000	
4	Tosham Distributary of Hansi Branch.	5,000	
5	Enlarging Bhiwani Distributary of Hansi Branch.	...	
6	Beri Bhalaut Distributary of Delhi Branch.	...	
7	Pai Rohana Distributary of Delhi Branch.	...	
8	Petwar Extension from Hansi Branch.	...	
9	Chautang and other distributaries in Head Reach of Sirsa Branch.	...	
	Total Receipts on Capital Account	11,000	

SUTLEJ DAM PROJECT.
WESTERN JUMNA CANAL EXTENSIONS.

ESTIMATE 15.

VI (23)—Capitalization of abatement of Land Revenue.

The provision for VI (23)—Capitalization of abatement of Land Revenue is kept the same as given in Sarda-Ganges Project.

The detail is as below :—

Serial No. of channels.	Name of channels.	Total amount of VI (23)—Capitalization of abatement of Land Revenue.	REMARKS.
		Rs.	
1	Enlarging Main Branch	
2	Enlarging Hansi Branch and Butana Branch.	5,475	
3	Enlarging Delhi Branch ...	225	
4	Tosham Distributary of Hansi Branch.	26,375	
5	Enlarging Bhiwani Distributary of Hansi Branch.	3,225	
6	Beri Bhalaut Distributary of Delhi Branch.	11,330	
7	Pai Robana Distributary of Delhi Branch.	5,520	
8	Petwar Extension from Hansi Branch.	...	
	Chautang and other distributaries in Head Reach of Sirsa Branch.	...	
	Total ...	52,150	

SUTLEJ DAM PROJECT.**WESTERN JUMNA CANAL EXTENSIONS.****ESTIMATE 16.****VI (25)—Leave and Pension Allowance.**

The provision for VI (25)—Leave and Pension Allowance is made at the rate of 14 per cent. of total II—Establishment.

The detail is as below :—

Serial No. of channel.	Name of channel.	Total amount of II—Establishment.	Rate per cent.	Total amount of VI (25)—Leave and Pension Allowance.	REMARKS.
		Rs.	Rs	Rs.	
1	Enlarging Main Branch ...	14,961	14	2,094	
2	Enlarging Hansi Branch and Butana Branch.	1,08,040	14	14,426	
3	Enlarging Delhi Branch ...	9,023	14	1,263	
4	Toshani Distributary of Hansi Branch.	1,05,726	14	14,802	
5	Enlarging Bhiwani Distributary of Hansi Branch.	41,080	14	5,877	
6	Beri Bhalaut Distributary of Delhi Branch.	55,677	14	7,795	
7	Pai Rohana Distributary of Delhi Branch.	19,808	14	2,773	
8	Petwar Extension from Hansi Branch.	38,240	14	4,054	
9	Chautang and other Distributaries in Head Reach of Sirsa Branch.	9,600	14	1,344	
	Total Leave and Pension Allowance.	3,93,055	14	55,028	

SUTLEJ DAM PROJECT.

WESTERN JUMNA CANAL.

APPENDICES.

APPENDIX A.

CAPACITY STATEMENT OF DELHI BRANCH.

(See Capacity Statement, Western Jumna Canal, 1916, Table 6, page 11, and Statement B, page 21.)

Name of Distributary.	Gross commanded area.	Culturable commanded area.	Per cent. irrigation proposed.	Annual irrigation proposed.	Full supply factor.	Full supply discharge required.	Changes.
Gohana Feeder	72,980	45	32,841	150	219	
Israna	45,072	45	20,282	150	135	
Naraina	12,112	45	5,450	150	36	
Hulana	26,408	45	11,883	150	79	
Rohtak	37,923	45	17,065	150	114	
Bhalaut, existing	143,081	83½	47,694	150	318	
Bhalaut proposed	45	64,386	...	429	+111
Bhainswali	28,087	45	12,909	150	86	
Jun	37,315	45	16,792	150	112	
Sonepat	10,337	45	4,670	150	31	
Pai	58,073	45	26,133	150	174	
Add extensions on Pai and Bhalaut	99,594	89,635	45	40,336	150	269	+ 269
Kakroi	4,338	45	1,952	150	13	
Lampur	6,774	45	3,018	150	20	
Bhawani	31,656	50	15,828	150	106	
Tail	27,714	50	16,872	Fixed supply	160	
Total of Distributaries	542,509	...	233,419	...	1,603	
Direct Water-courses	5,460	50	2,730	175	16	
Railway Tanks	3	
Total Delhi Branch, existing	1,622	
Add Absorption 6 Cusecs per mill.	103	
Total existing Head Delhi Branch including Gohana Feeder.	547,969	...	236,149	...	1,725	
Add extra as above	89,635	...	57,028	...	380	
Total now required including Gohana	637,604	...	293,177	...	2,105	
Deduct Gohana Feeder*	72,980	...	32,841	...	219	
Total Head Discharge now required	564,624	260,336	...	1,886	

*The Head of the Gohana Feeder is now on the tail of the Main Branch above the Head of the Delhi Branch.

APPENDIX B.

CAPACITY STATEMENT OF HANSI BRANCH.

(See Capacity Statement, Western Jumna Canal, 1916, Table 6, page 11, and Statement C, page 22.)

Name of Distributary.	Gross commanded area.	Culturable commanded area.	Per cent. irrigation proposed.	Annual irrigation proposed.	Full supply factor.	Full supply discharge required.	Changes.
<i>British.</i>							
Joshi	5,980	50	2,985	150	20	
Muana	17,059	50	8,530	150	57	
Other Water-courses	667	50	334	75	2	
Mahaudpur	38,454	50	19,227	175	110	
Narnaund	8,140	75	6,105	175	35	
Hissar	46,814	75	34,738	175	201	-40
Hissar in Bikaner State	1,762	Fixed figure.	460			
Deduct area on Hissar Distributary transferred to Barwala.	16,667	-15,000	40	-6,000	150	-40	
Petwar	150,952	50	75,476	175	431	
New, South-West of Hissar near Balsamand.	64,000	57,600	40	23,000	150	153	+153
Railway Tanks...	5	
Total Hansi Branch British, existing	...	209,278	...	147,833	...	861	
<i>Jind State.</i>							
Jind No. 1	19,801	...	7,700	...	44	
" " 2	2,676	...	1,050	...	6	
" " 3	78,144	...	15,575	...	89	
" " 4	58,488	...	17,325	...	99	
" " 5	20,189	...	6,850	...	43	
" " 6	19,196	...	3,850	...	27	
" " 7	7,502	...	3,325	...	19	
" " 8	7,868	...	1,575	...	10	
State Garden outlet	1,077	...	1,725	...	9	
Total Jind	214,391	...	58,775	...	346	
Grand Total Hansi Branch, existing...	...	483,669	...	206,608	...	1,207	
Add absorption at 6 cusecs per mill.	110	
Total Head, existing	483,669	...	206,608	...	1,317	
Add extra as above	42,600	...	17,000	...	113	
Total Head discharge now required...	...	526,269	...	223,608	...	1,430	

APPENDIX C.

CAPACITY STATEMENT OF BUTANA BRANCH.

(See Capacity Statement, Western Jumna Canal, 1916, Table 6, page 11, and Statement C, page 22.)

Name of Distributary.	Gross commanded area.	Culturable commanded area.	Per cent irrigation proposed.	Annual irrigation proposed.	Full supply factor.	Full supply discharge required.	Change.
Direct Outlets above Anchara	...	9,854	50	4,927	150	33	
Direct Outlets below Anchara	...	25,236	40	10,094	150	67	
Direct Outlets for Jind State	...	4,841	...	1,225	..	7	
Gangawar	7,554	50	3,792	150	25	
Butana	32,080	50	16,030	150	107	
Toshani ...	244,372	219,934	40	87,974	150	586	+ 586
Bhiwani	139,463	33½	46,468	150	310	
...	40	55,785	150	372	+ 62
Kanhar	1,20,828	33½	40,109	150	268	
...	40	48,131	150	322	+ 54
Dadri Extensions	20,000	18,000	40	7,200	150	48	+ 48
Railway Tanks	3	
Total Butana Branch, existing	...	339,366	..	122,005	...	820	
Add absorption 6 cusecs per mill.	53	
Total Head, existing	...	339,366	..	122,005	...	873	
Add extra as above	...	237,934	...	112,493	...	750	
Total Head Discharge now required	...	577,300	...	235,158	...	1,623	

STATEMENT SHOWING CAPACITY OF HEAD REACH OF THE SIRSA BRANCH FED FROM WESTERN JUNNA CANAL.

REDUCED DIS- TANCE OF HEAD REACH.	Height of fall.	CANAL DIMEN- SIONS		Bed slope 1 in.	CAPA- CITY	WETTED PERIMETER AND AREA.		ABSORPTION AT 8 CUSSES PER MILLION SQUARE FEET OF WETTED AREA.		Name of distributaries.	AREA IN ACRES ACCORDING TO CAPACITY AND WORKING OF DISTRIBUTARIES STATE- MENT 1916-16 OF WEST- ERN JUNNA CANAL.				PERCENTAGES OF AREA.			DRAW OFF.		CAPACITY REQUIRED.	REMARKS.		
		Exist- ing.	F.S. depth.			Per- imeter, of square feet.	Area in millions feet.	Dist- ing.	Pro- posed.		Gross area.	Cultor- able com- manded area.	Proposed irriga- tion.	Succ- tioned.	Per cent. as per work- ing condi- tion.	Pro- posed dis- charge.	Pro- posed dis- charge.						
Mile	Feet.	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
1	33	1.814	6.6	7.5	5.714	...	71.2	1.2	...	180	1,010	*The discharge 88
2	30	10	5,636	5,210	1,797	33 1/2	12	14	cuses for Chau-
3	25	2,330	3.4	7.5	5,714	1,307	76.2	1.7	13,533	12,239	4,050	33 1/2	40	40	27	38	1,220	ang Distributary
4	20	3,651	3.4	7.5	5,714	...	76.2	1.7	7,507	7,199	2,400	33 1/2	16	19	is fixed according
5	17	3,655	0.9	7.5	5,714	1,327	75.2	1.1	7,495	6,695	2,228	33 1/2	15	18	to paragraph 3 of
6	8	33	6,339	5,235	1,755	33 1/2	1,328	note, dated 29th
7	42,685	37,315	12,417	33 1/2	1,319	July 1917, by the
8	188,200	164,625	54,743	33 1/2	363	435	Superintending En-
9	61,559	44,210	10,200	ginner, Western Cir-
10	cle.
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NOTE-1. Column No. 21 x 40

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2. Proposed irrigation for Chaurang Distributary 10,200 acres = discharge x F.S. Factor = 88 x 150.
The 88 cusses of total atorption is taken from paragraph 4 (b) of note, dated 29th July 1916, by the Superintending Engineer, Western Junna Canal Circle, as worked out according to the changes in channel made by him.
The total extra supply given to existing Distributaries gives a proposed irrigation of 13,200 acres thus 1-88 cusses x 150 F.S. Factor = 13,200 acres.

*The discharge 88 cusses for Chaurang Distributary is fixed according to paragraph 3 of note, dated 29th July 1917, by the Superintending Engineer, Western Junna Canal Circle.

APPENDIX F.
STATEMENT SHOWING BY BRANCHES THE EXISTING CONDITIONS OF THE WESTERN JUMNA CANAL AND THOSE AFTER THE CONSTRUCTION OF SUTLEJ DAM PROJECT.

Names of Branches.	Source of information.	AREAS IN ACRES.				INTENSITY.		Full Supply Factor.	Total Discharge at distributory heads.	Total Absorption.	Total Discharge required at head of branches	REMARKS
		Gross area.	Cultivable commanded area.	Proposed irrigation.	Average irrigation of 3 years, 1911-14.	Proposed	Actual.					
1	SIKSA BRANCH	8	5	0	7	8	9	10	11	12	13	14
	Statistical Statement, 1912-13.	801,809	737,116	228,978	263,605	81 %	88 %	...	1,683	221	1,700	See Appendices D and E.
	Capacity Statement, 1916, of Western Jumna Canal	800,604	683,278	227,373		83 %	89 %	130 to 175	1,587			
	1916 { Cut off by Upper Sirhind Canal ...	570,880	482,055	160,427	104,614	33 %	39 %	130 to 175	1,122	190	1,112	
	{ Left on Western Jumna Canal	229,722	201,223	68,946	68,361	39 %	39 %		445	33	478	
	Extra Supply given to Existing Distributaries, left on Western Jumna Canal.	13,200	150	88	
	Extensions	61,859	44,210	10,200	..	40 %	..	150	68	
	Total additional	61,859	44,210	23,400	150	156	
	Total for Branch	291,581	245,433	90,346	601	33	634	
2	MAIN LINE	10,065	7,259	3,942	4,164	51 %	57 %	..	20	No changes in Main Line.
	Statistical Statement, 1912-13, and Capacity Statement, 1916, of Western Jumna Canal.	10,065	7,256	3,942	..	54 %	57 %	150	28	150	176	
	Total for Branch	10,065	7,256	3,942	..	54 %	..	150	26	150	176	
3	DELHI BRANCH.	603,780	540,119	223,055	107,131	42 %	31 %	...	1,689	See Appendix A.
	Statistical Statement, 1912-13, and Capacity Statement, 1916, of Western Jumna Canal.	603,920	547,969	236,140	..	43 %	31 %	150 to 175	1,822	103	1,725	
	Extra Supply given to Existing Distributaries.	16,692	150	111	
	Extensions	99,594	89,635	40,336	..	45 %	269	
	Total additional	99,594	89,635	57,028	380	
	Total for Branch	753,514	637,604	293,177	2,002	103	2,105	

MAIN BRANCH	Statistical Statement, 1912-13, and { Capacity Statement, 1916, of Western Jumna Canal.	1912 1916	259,456 257,040	235,518 209,829	73,306 75,782	{ 57,093 }	31 % 33 %	24 % 27 %	120 to 175 150	465 530	262 262	792 792	No changes in Main Branch.
	Total for Branch	...	257,040	209,829	75,782	...	33 %	27 %	150	530	262	792	...
HANSI BRANCH	Statistical Statement, 1912-13, and { Capacity Statement, 1916, of Western Jumna Canal.	1912 1916	558,810 574,558	486,652 483,668	181,048 203,608	{ 216,304 }	37 % 43 %	44 % 45 %	...	1,313 1,207	See Appendix B.
	Extensions	...	64,000	57,600	23,000	...	40 %	...	150	153
	Deduct for tail portion of Hissar Major Distributary cut off by Upper Sirhind Canal System.	...	-18,667	-15,000	-8,000	...	40 %	...	150	-40
	Total additional	...	47,333	42,600	17,000	...	40 %	...	150	113
	Total for Branch	...	621,891	526,259	223,608	1,320	110	1,430	...
BUTANA BRANCH	Statistical Statement, 1912-13, and { Capacity Statement, 1916, of Western Jumna Canal.	1912 1916	354,129 376,624	290,715 338,366	95,231 123,685	{ 79,288 }	81 % 36 %	27 % 23 %	...	615 820	See Appendix C.
	Extra Supply given to Existing Dis- tributaries	17,319	116
	Extensions	...	264,372	237,934	95,174	...	40 %	...	150	634
	Total additional	...	264,372	237,934	112,493	750
	Total for Branch	...	640,996	577,300	235,158	1,570	53	1,623	...
	Total Western Jumna Canal in 1912	...	2,623,218	2,296,376	808,933	5,638
	Total Western Jumna Canal in 1916	...	2,873,409	2,270,807	876,519	5,773	901	6,873	...
	Total transferred to Upper Sirhind Canal System	...	570,860	482,055	160,437	1,122	190	1,812	...
	Total left on Western Jumna Canal System	...	2,102,529	1,788,812	715,692	4,650	71	5,361	...
	Total Extra given to Existing Distributaries, Western Jumna Canal System.	47,211	315
	Total Extensions on Western Jumna Canal System	...	473,158	414,379	162,710	1,084
	Total additional on Western Jumna Canal System	...	473,158	414,379	209,921	1,399
	Total of Western Jumna Canal on completion of Sutlej Dam Project.	...	2,575,687	2,203,191	922,013	6,049	711	6,760	...

APPENDIX

**STATEMENT SHOWING THE WORKING OF THE DISTRIBUTARIES ON THE EXISTING
BY SECTIONS ACCORDING TO WHICH THE CHANGES**

Serial No. of Item.	Items.	Source of information.	LOWER SIRHIND CANAL, PROPOSED.		UPPER SIRHIND		
			SIRHIND CANAL EXISTING.				
			Abohar Branch below Daudhar at mile 43 perennial distributaries	Bhatinda Branch below Dhipali at mile 56 perennial distributaries.	Abohar Branch head to Daudhar at mile 18 perennial distributaries	Bhatinda Branch head to Dhipali at mile 56 perennial distributaries.	Abohar and Bhatinda Branches, Kharif Distributaries
1	2	3	4	5	6	7	8
1	Gross area within irrigation limit	S. Statement, 1912-13	1,084,373	565,782	187,995	516,901	152,191
2	Culturable commanded area	Ditto	982,536	515,100	178,058	445,214	139,569
3	Area proposed to be irrigated	Ditto	410,556	171,820	60,800	121,740	16,930
4	Per cent. of culturable commanded area proposed to be irrigated in remodelling, 1905.	Remodelling, records	40 %	33½ %	40 %	33½ %	16½ %
5	Per cent. of culturable commanded area on present working figures.	Line 3+line 2	43 %	33 %	34 %	27 %	11 %
6	Total area irrigated in both crops	S. Statement, A. 1911-14	331,677	215,010	69,753	133,262	26,683
7	Percentage area irrigated on G. C. A.	Line 6+line 1	49 %	38 %	32 %	25 %	18 %
8	Percentage area irrigated on C. C. A.	Line 6+line 2	55 %	42 %	34 %	30 %	17 %
9	Area irrigated in Kharif	S. Statement, A. 1911-14	172,502	87,307	19,118	44,790	10,241
10	Percentage area irrigated in Kharif on G. C. A.	Line 9+line 1	16 %	12 %	10 %	9 %	7 %
11	Percentage area irrigated in Kharif on C. C. A.	Line 9+line 2	14 %	13 %	11 %	10 %	7 %
12	Area irrigated in Rabi	S. Statement, A. 1911-14	359,375	147,703	40,640	88,472	19,442
13	Percentage area irrigated in Rabi on G. C. A.	Line 12+line 1	33 %	26 %	22 %	17 %	10 %
14	Percentage area irrigated in Rabi on C. C. A.	Line 12+line 2	37 %	28 %	23 %	20 %	10 %
15	Proportion Kharif : Rabi irrigation	Line 9+line 12	1:2.08	1:2.19	1:2.11	1:1.97	1:1.81
16	Average No. of days canal run, Kharif	S. Statement, A. 1911-14	161				
17	" " " " " " Rabi	Ditto	177				
18	Time factor, Canal Main Line, Kharif	Line 16+163	85				
19	" " " " " " Rabi	Line 17+162	97				
20	Full Supply factor proposed when channels remodelled in 1905-09.	Remodelling, records	170				
21	Full Supply factor from present working figures	Line 3+line 22	185	164	220	170	62
22	Total sanctioned discharge of distributaries	S. Statement, 1912-13	2,218	1,054	277	715	245
23	Mean discharge on No. of days, { Kharif ... Rabi ...	S. Statement, A. 1911-14,	1,164	516	120	359	87
24		Ditto	1,318	560	170	396	27
25	Capacity factor, Kharif	Line 23+line 22	.52	.49	.40	.50	.35
26	" " " " " " Rabi	Line 24+line 22	.59	.54	.60	.56	.41
27	Duty, Kharif	Line 9+line 23	148	130	160	135	118
28	" " " " " " Rabi	Line 12+line 24	273	261	238	224	198
29	Full Supply factor, Kharif	Line 9+line 22	78	64	70	63	41
30	" " " " " " Rabi	Line 12+line 22	162	140	146	124	55
31	" " " " " " Both crops	Line 29+line 30	240	204	216	187	96
32	Rainfall mean 3 years, Kharif	S. Statement, A. 1911-14	7.1	7.1	10.4	9.9	12.2
33	" " " " " " Rabi	Ditto	2.1	2.3	2.9	2.7	3.4

G

SIRHIND AND WESTERN JUMNA CANALS FOR THE AVERAGE OF 3 YEARS 1911-14
WILL TAKE PLACE UNDER THE SUTLEJ DAM PROJECT.

CANAL PROPOSED.

WESTERN JUMNA CANAL, PROPOSED.

WESTERN JUMNA CANAL, EXISTING.											
Serial No. of Item.	Sirsa Branch.		Sirsa Branch.	Hansi Branch.		Butana Branch.		Delhi Branch.		Main Branch.	
	Below junction of Tobana Branch, mile 85 tail.	Below junction of Sirsa Feeder, miles 34-65	Above junction of Sirsa Feeder, miles 0-30	S. State-ment, 1912.	1916 Capacity Statement.	S. State-ment, 1912.	1916 Capacity Statement.	S. State-ment, 1912.	1916 Capacity Statement.	S. State-ment, 1912.	1916 Capacity Statement.
	9	10	11	12	13	14	15	16	17	18	19
1	178,386	392,514	229,722	588,310	574,558	854,129	376,824	606,780	653,920	259,445	257,040
2	142,892	359,168	201,223	486,652	463,669	299,715	330,866	540,119	547,969	235,518	209,329
3	47,630	112,797	66,946	181,915	205,808	93,234	122,566	226,065	236,149	73,336	78,782
4	33 1/2 %	33 1/2 %	33 1/2 %
5	33 %	33 %	33 %	37 %	43 %	31 %	36 %	42 %	48 %	31 %	35 %
6	61,623	131,021	68,961	216,304		79,283		167,161		57,002	
7	35 %	34 %	32 %	37 %	38 %	22 %	21 %	27 %	26 %	22 %	22 %
8	43 %	41 %	34 %	44 %	45 %	27 %	23 %	31 %	31 %	24 %	27 %
9	21,974	63,751	29,180	114,733		41,495		80,178		24,487	
10	12 %	16 %	13 %	19 %	20 %	12 %	11 %	13 %	12 %	9 %	9 %
11	15 %	19 %	14 %	23 %	24 %	14 %	12 %	15 %	15 %	10 %	12 %
12	39,640	69,270	30,181	101,011		37,793		86,963		32,604	
13	22 %	18 %	17 %	17 %	18 %	11 %	10 %	14 %	13 %	13 %	13 %
14	28 %	20 %	19 %	21 %	21 %	13 %	11 %	16 %	16 %	14 %	16 %
15	1:18	1:109	1:13	1:09		1:091		1:11		1:13	
16	<-----180----->										
17	<-----182----->										
18	<-----95----->										
19	<-----10----->										
20	<-----150----->										
21	189	145	153	138	171	142	149	142	118	151	140
22	344	776	445	1,313	1,207	656	820	1,586	1,622	405	539
23	191	453	216	966		380		783		263	
24	198	313	156	596		224		539		193	
25	55	59	49	75	82	51	46	49	48	57	50
26	53	44	35	45	49	34	27	34	33	41	38
27	115	189	138	116		109		102		93	
28	217	202	248	170		169		161		169	
29	64	86	60	87	95	63	51	50	49	53	48
30	105	93	88	77	34	57	46	55	54	70	61
31	179	179	154	164	179	120	87	105	103	123	107
32	82	110	148	108		135		146		173	
33	15	20	21	25		31		26		34	

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Sirhind Canal.



APPENDIX H.

CAPACITY STATEMENT OF EXISTING SIRSA BRANCH, WESTERN JUMNA CANAL.

Reduced distances of reaches.	Height of fall.	CANAL DIMENSIONS.		Bed slope.	Remodelled capacity.	WETTED PERIMETER AND AREA.		Absorption @ 8 canals per million.	DRAW OFF.				CAPACITY REQUIRED.	
		Bed width.	Depth.			Perimeter.	Area in millions square feet.		Distributaries.	Per cent. Irrigation sanctioned.*	As per working court-ous 1911-1913	Sanctioned discharge.*	Khurif.	Rabi.
Trail 573,000— To R D. 550,000	...	23	4.4	0.066	200	35.4	82	7	Danawali Mr. Ding Mr. SIRSA	33½ 33½	8 5 154	209	
To 587,100 ... To 610,500 ...	20 20	21 29	4.4 4.4	0.066 0.066	211 260	36.4 41.4	47 85	4 7	Fatehabad Adampar D	33½ 33½	5 41	213 261	
To 474,300 ...	2.5	30	5	0.066	318	44.1	86	14	Mohammadpur Mr. Direct outlet	33½ 33½	26 14	315	
To 425,500 ...	1.0	32	5	0.066	316	46.1	2.25	18	Bahana Mr.	33½	...	9	342	
To 392,500	3.5	33	5.4	0.066	420	48.3	1.59	13	GORAKHPUR Hansawala Mr.	33½ 33½	52 4	411	
To 371,750	2.5	47	5.7	0.066	663	63.1	1.32	10	Ujjana Mr. PAHRA	33½ 33½	15 203	639	
To 328,500 ...	2.0	48	5.8	0.066	667	64.4	2.77	22	Sainthly Mr.	P P	13	674	
To 315,775 ...	1.5	49	5.8	0.066	701	65.4	85	7	Narwana Sancha Khara Mr	P P	20 18	714	
To 278,600 ...	2.0	49	6.0	0.066	754	66.0	2.4	19	Dalkhal Mr. Direct outlet	P P	15 3	751	
To 242,700 ... To 225,950 ... To 205,646 ... To 199,930 ...	3.5 ... 3.8 ...	49 49 40 40	6.1 6.2 7.5 7.6	0.066 0.066 5.714 5.714	766 791 1,021	66.3 66.5 61.2 61.2	2.38 1.13 1.4 0.9	19 9 11 7	Hatch Mr. DHAVTAN	P P	... 33½ 19 175 ...	770 798 954 991	
To 166,944 ...	8.8	50	7.5	5.714	1,242	71.2	1.65	13	Tilum Branch SUDKAN	P P	33½ 33½	51 165	1,220	
To 150,000 ..	5.5	50	7.5	5.714	...	71.2	1.2	10	1,230	
To 127,330	3.1	54	7.5	5.714	1,307	75.2	1.7	13	Fatehpur Mr. Chandana Mr.	33½ 33½	12 27	1,263	
To 103,651 ...	3.4	54	7.5	5.714	...	75.2	1.7	14	Mohna Mr. Kani Mr.	33½ 33½	16 15	1,328	
To 88,585 To 40,138 ..	0.9 ...	54 79	7.5 6.9	5.714 5.714	1,327 1,827	75.2 93.61	1.1 4.78	9 38	Karna Mr. HABRI	... P	33½ 33½	12 445	1,349 1,682	
To Head	87	6.9	5.714	1,850	108.5	4.25	34	1,861	

Total absorption

Total drawn off of distributaries

* Figures taken from Capacity Statements, Western Jumna Canal, 1918.
Note.—Distributaries belonging to Patiala State entirely marked P.

